GATES LEARJET CORPORATION

maintenance manual

CHAPTER

76

ENGINE CONTROLS

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POWER CONTROL - DESCRIPTION AND OPERATION

1. Description

A. The engine throttle control consists of the thrust levers located in the center pedestal and two cable assemblies for each engine.

B. Two thrust levers, located in the cockpit center pedestal, control engine power by regulation of each engine fuel control unit. The thrust levers are connected to the fuel control unit by cables with adjustable clevis ends. Positive stops are provided in the thrust quadrant to retain the thrust levers in the cutoff position and prevent inadvertent reduction of thrust below the idle position. Throttle aural warning switches are located in the center pedestal. The switches will actuate the aural warning at approximately 68% engine rpm when the landing gear is in the up position.

C. Two throttle cables for each engine are used to transmit the thrust lever setting to the engine. The forward throttle cable is routed under the center floorboards, through a pressure seal at frame 15, through the keelbeam, and into the tailcone area. At this location, the forward cable is coupled to the aft cable by a coupling nut. The aft cable is routed through a cable guide, mounted on the engine pylon firewall, and to the right side of the engine. The end of the cable is connected to the engine fuel control bellcrank by a clevis.

D. Some aircraft have an engine synchronizer system installed or an engine synchroscope (indicator). Refer to 76-11-00 for engine synchronizer system description and operation.

THROTTLE QUADRANT - MAINTENANCE PRACTICES

1. Removal/Installation

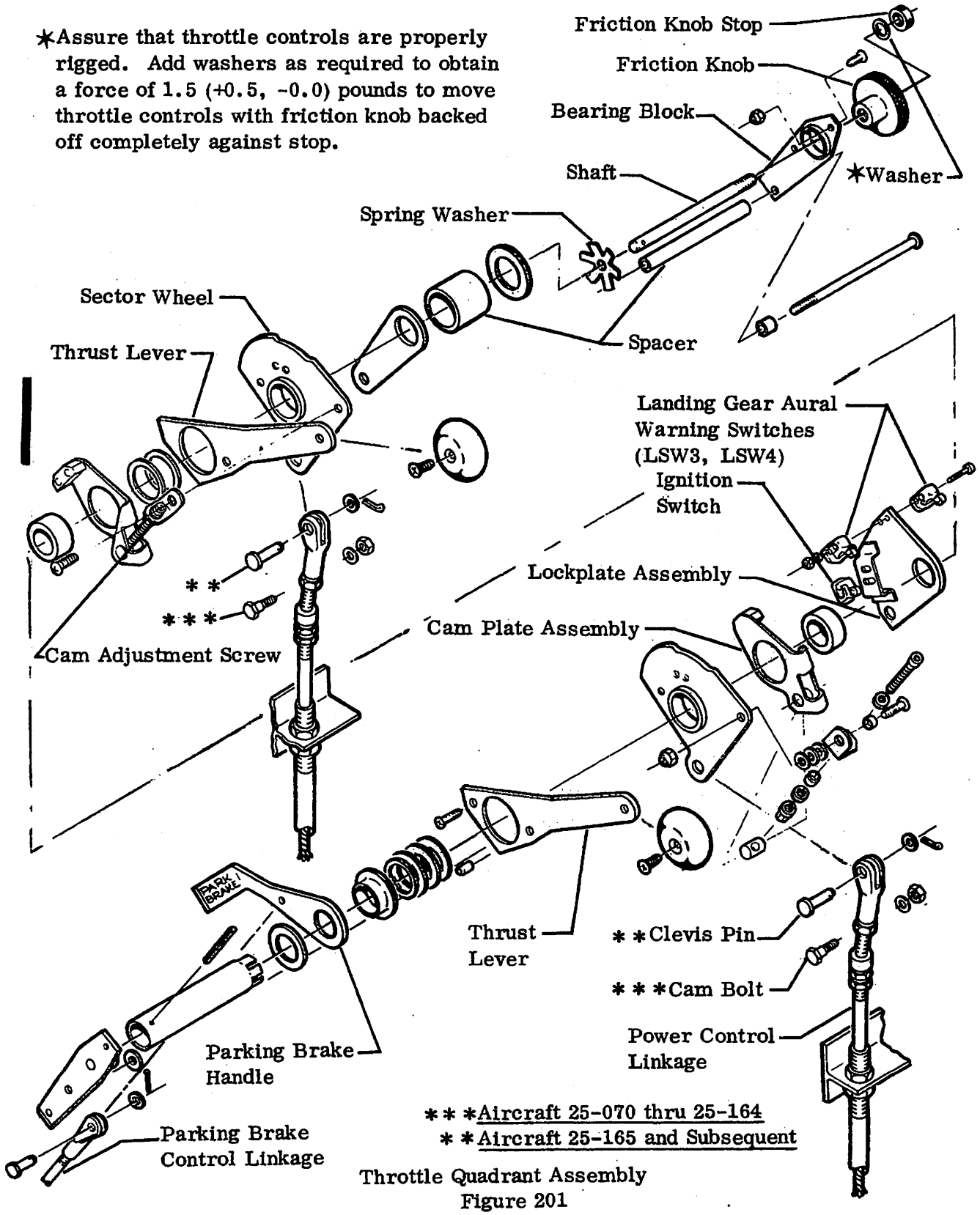
A. Remove Throttle Quadrant (See figure 201.)

(1) Remove electrical power from aircraft.
(2) Remove flap switch control knob.
(3) Remove cap from top LH side of pedestal.
(4) Remove thrust lever knobs.
(5) Remove pedestal cover from pedestal.
(6) Remove engine synchronizer switch (if installed) from support bracket.
(7) Remove spoiler switch from support bracket.
(8) Disconnect electrical wiring from autopilot release switch.
(9) Remove ignition and aural warning switches from lockplate assembly.
(10) Remove parking brake control linkage from parking brake handle.
(11) Remove power control linkage from sector wheel.
(12) Remove friction knob stop and friction knob from shaft.
(13) Remove throttle quadrant from pedestal, making certain not to damage wiring.

B. Install Throttle Quadrant (See figure 201.)

(1) Install throttle quadrant in pedestal and secure with attaching parts.
(2) Install friction knob and friction knob stop on shaft.
(3) Install power control linkage on sector wheel.
(4) Install parking brake control linkage on parking brake handle.
(5) Install ignition and aural warning switches on lockplate assembly.
(6) Connect electrical wiring to autopilot release switch.
(7) Install spoiler switch on support bracket.
(8) Install engine synchronizer switch on support bracket.
(9) Install pedestal cover on pedestal.
(10) Install thrust lever knobs.
(11) Install cap on pedestal.
(12) Install flap switch control knob.
(13) Restore electrical power to aircraft.

✶Assure that throttle controls are properly rigged. Add washers as required to obtain a force of 1.5 (+0.5, -0.0) pounds to move throttle controls with friction knob backed off completely against stop.



* * *Aircraft 25-070 thru 25-164
* *Aircraft 25-165 and Subsequent

Throttle Quadrant Assembly
Figure 201

2. Adjustment/Test

A. Landing Gear Aural Warning Switch Adjustment (See figure 202.)

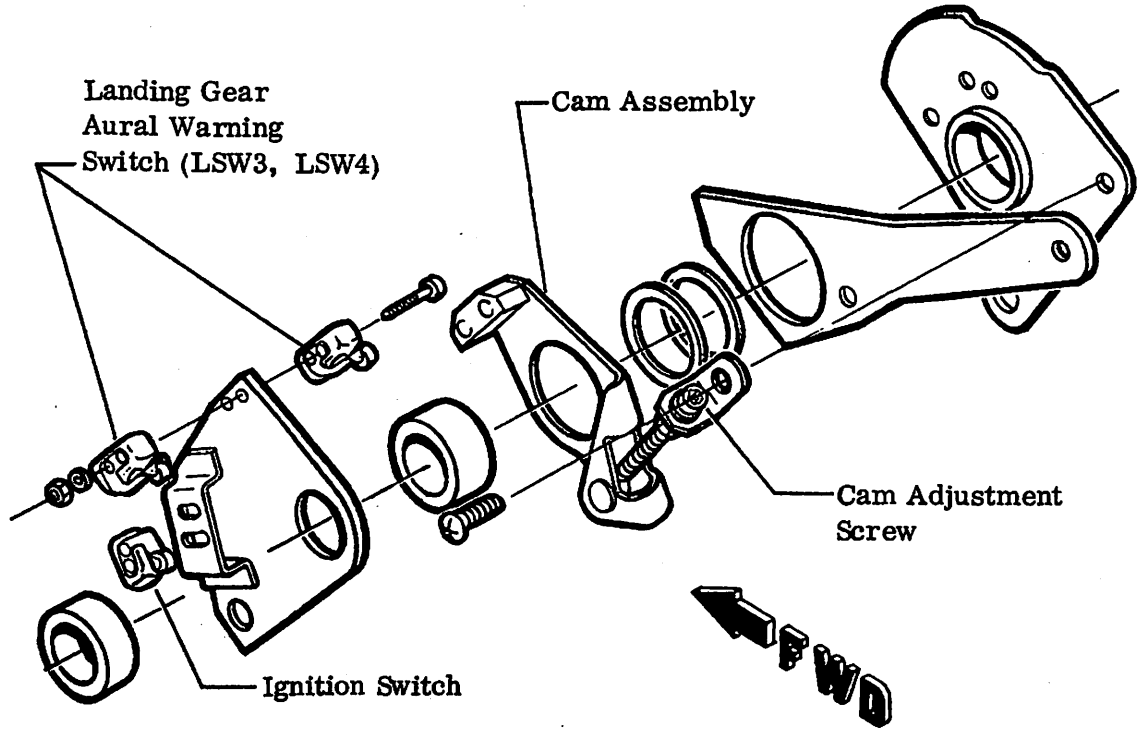
NOTE: Position thrust levers and adjust switches individually.

(1) Inflight adjustment of camplate assemblies which actuate landing gear aural warning switches is provided by recessed head cam adjustment screws. Insert an Allen wrench through access cutout in pedestal cover for screw adjustment. With aircraft in flight and landing gear in up position, perform the following:

(a) Position thrust levers to 68% (+2%, -3%) rpm as indicated on engine tachometer.

(b) Turn cam adjustment screws until aural warning horn sounds from 68% (+2%, -3%) rpm to thrust levers cutoff position.

(c) Refer to Chapter 74 for Ignition Switch Adjustment.

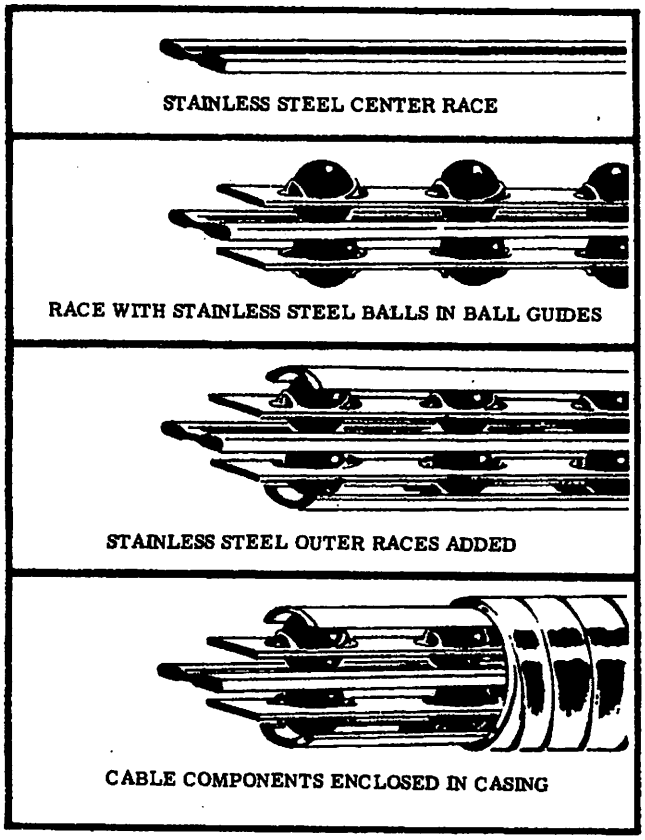


Landing Gear Aural Warning Switch Adjustment
Figure 202

THROTTLE CABLE - DESCRIPTION AND OPERATION

1. General

A. The throttle cable has linear-mounted ball bearings that are held in place by ball separators and outer races. Located between the ball bearings is a grooved center race where motion is transmitted with a minimum of friction from thrust lever to engine fuel control bellcrank. The outer races, ball separators, ball bearings, and center race are encased in flexible metal tubing. Cable removal and installation is made easier by providing a forward and an aft section coupled together by a coupling nut. The forward throttle cable end is connected by a terminal to the thrust lever, located at the center pedestal.



Throttle Cable
Figure 1

THROTTLE CABLE - MAINTENANCE PRACTICES

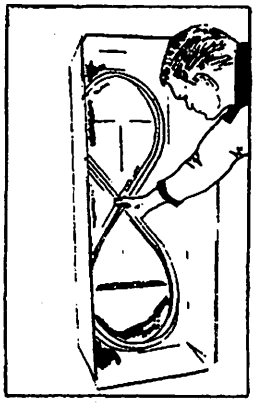
1. General
 A. Maintenance practices consist of removal and installation adjustment and rigging of the throttle control cables.

2. General Control Cable Handling and Installation Precautions
 A. Maintenance personnel should familiarize themselves with the following precautions before removal and installation of the throttle control cable.
 (1) Pliers or similar devices should not be used to grip the control cable.
 (2) Wrenches are to be used on wrench flats to prevent twisting of the control cable when torquing jamnuts or attaching hardware.
 (3) Minimum bend radius of control cable is six inches in the direction of the arrow on the wrench flat.
 (4) Do not attempt bends opposite the arrow as cable binding will result and possible damage to the cable could result.
 (5) Do not lubricate the control cable.
 (6) Do not force sliding member against the internal stops.
 (7) All clamps should be tightened firmly. Clamps are for support only and overtightening could result in binding.

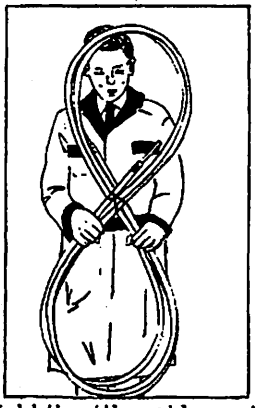
3. Removal/Installation
 A. The following procedure is applicable for removal of either throttle cable. It is recommended that one cable be removed and new cable installed prior to removing the remaining cable. This will provide a guide for routing, clamping, and positioning the new cables.
 B. Remove Throttle Cable (See figure 202)

 CAUTION: IT IS EXTREMELY IMPORTANT THAT THE THROTTLE CABLE BE HANDLED AS A DELICATE INSTRUMENT. BENDING OF THE CABLE IN THE WRONG PLACE WILL RESULT IN JAMMING OF THE THROTTLES.

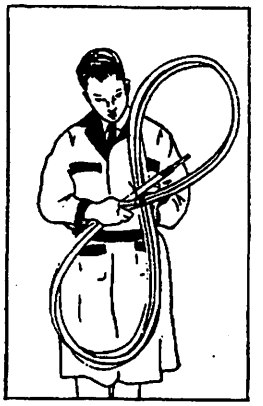
 (1) Remove the tailcone access door and disconnect aircraft batteries and remove from aircraft.
 (2) Remove lower engine nacelle.
 (3) Remove safety wire and disconnect throttle cable at ball joint connector (refer to detail "H").
 (4) Remove safety wire and loosen jamnuts securing cable to cable support bracket. Remove forward jamnut and washer (refer to detail "G").
 (5) Remove clamps securing throttle cable to engine. Pull cable clear of support bracket and remove remaining washer and jamnut.
 (6) Remove asbestos wrap or firesleeve from throttle cable.
 (7) Remove bolts securing throttle cable guide to pylon firewall. This will allow removal of cable without binding inside the pylon (refer to detail "F").



1. The throttle control cable is shipped in a figure 8 configuration.



2. Hold throttle cable upright in both hands.



3. Remove shipping wire. Starting with end fitting nearest you, play out loops one at a time without forcing or twisting.



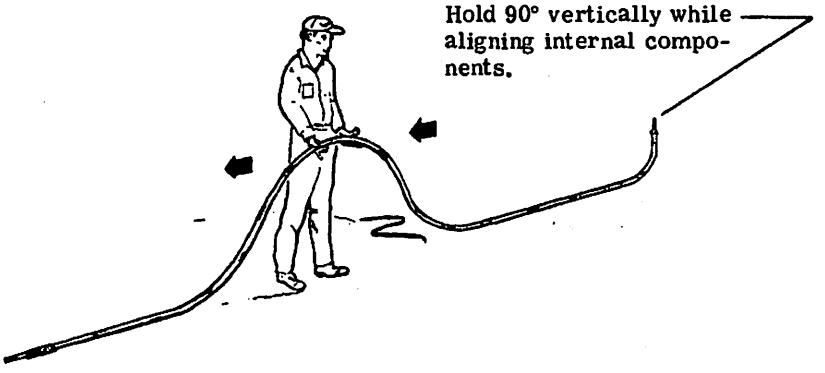
4. Final figure 8.



5. Play out final loop.



6. Throttle control cable is ready for installation.



7. Lay throttle cable on floor. With end opposite quick-disconnect held vertically to form a 90° bend, have another man establish a hump in the cable and carry it through to the quick-disconnect as shown. This will straighten the internal components.

STRAIGHTENING THROTTLE CABLE
Throttle Cable Handling
Figure 201

(8) Remove support clamps and support halves and disconnect cable coupling.
(9) Pull throttle cable out through tailcone access opening while at the same time feeding the cable through the pylon.
(10) Remove all center access panels from beneath the aircraft.
(11) Remove clamps securing throttle cable to aircraft structure (refer to detail "D").
(12) Remove carpet and floorboards from area between center pedestal and frame 15.
(13) Remove screws securing fuel control panel to center pedestal. Lift fuel control panel sufficiently to gain access to electrical plug and disconnect plug. Remove remaining panels from center pedestal in the same manner.
(14) Remove screws securing pedestal extension covers to floor structure and remove pedestal extension covers from aircraft. Remove screws and quadrant cover from pedestal.
(15) Remove safety wire from ball joint and disconnect ball joint connector from cable (refer to detail "A").
(16) Remove dust cap. Remove safety wire, jamnut and washer securing throttle cable bracket.
(17) Remove screws and throttle cable support.
(18) Cut waxed string and heat-shrink tubing from both ends of vent tube assembly. Remove remaining washer and jamnut and remove vent tube assembly.
(19) Remove cable retainers and sealant at frame 15 feedthru (refer to detail "C").
(20) Pull throttle cable through tailcone access until cable is clear of the aircraft.

C. Install Forward Throttle Cable (See figure 202)

CAUTION: IT IS EXTREMELY IMPORTANT THAT THE THROTTLE CABLE BE HANDLED AS A DELICATE INSTRUMENT. BENDING OF THE CABLE IN THE WRONG PLANE WILL RESULT IN JAMMING OF THE THROTTLE.

NOTE: The following procedure is applicable for either forward throttle cable.

(1) The throttle cables are shipped in a figure 8 configuration. To prevent damage, unfold as shown in steps (1) through (6) of figure 201.
(2) The forward throttle cables have a built-in 90^{o} bend. The cables must have the internal components aligned properly prior to installation. This can be accomplished by laying the cable on the floor and, with one man holding the 90^{o} bend at one end vertically, have another man establish a hump at this end and carry it through to the opposite end as shown in step (7) of figure 201.

(3) Stroke the cable rod back and forth by hand; cable rod should move freely without any sign of excessive or increasing loads or erratic movement.
(4) With the throttle cable properly aligned, form a moderately large loop at the aft end (quick-disconnect end). Retain this loop during routing of throttle cable. This helps prevent the cable from twisting during installation.
(5) Insert end of throttle cable through tailcone access opening and route through keel beam to frame 15 feedthrough (refer to detail "J").
(6) Insert end of throttle cable through applicable frame 15 feedthrough and route cable forward and up to the center pedestal (refer to details "K" and "L").
(7) Cut two pieces of heat-shrink tubing (RNF 100-5/8, manufactured by Rayclad Tubes, Inc., Redwood City, Calif. or equivalent) 1.25 to 1.50 inches long.
(8) Slide a piece of the tubing over the throttle cable barrel and install vent tube assembly.
(9) Postion centerline of vent tube outlet 2.25 ($\pm$.12) inches below the base of the threads on the throttle cable barrel and rotate so that vent tube will match plumbing (refer to detail "Q").
(10) Slide remaining piece of heat-shrink tubing onto throttle cable barrel. Position both pieces so that equal lengths overlap vent tube assembly and throttle cable barrel (refer to detail "Q").
(11) Shrink tubing for 10 seconds at approximately 240°F using a heat gun.
(12) Double wrap and tie over the heat shrink tubing using waxed nylon tying tape (MIL-T-43435, Type I, Finish B, manufactured by Sunset Line and Twine, Petaluma, Calif.) (refer to detail "Q").
(13) Install jamnut and washer on throttle cable barrel and insert barrel through the throttle cable bracket.
(14) Install remaining washer and jamnut on throttle cable barrel. Adjust jamnuts so that throttle cable barrel extends 2.125 ($\pm$.125) inches above throttle cable bracket (refer to detail "Q"). Safety wire jamnuts. Do not connect or clamp cable at this time.
(15) Install dust cap over throttle cable barrel.

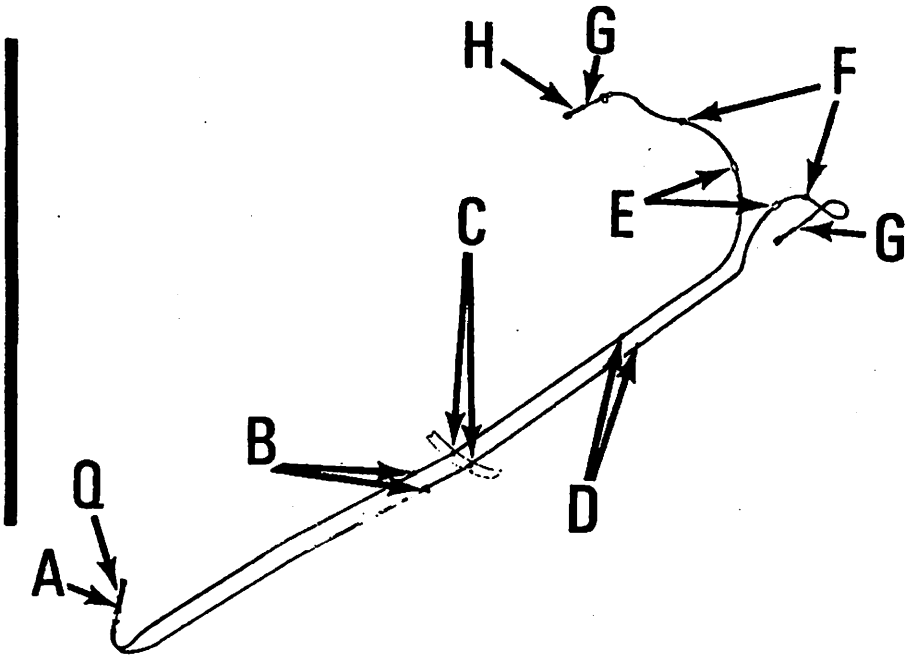
NOTE: When installing a new dust cap, do not enlarge hole for throttle cable rod. If friction is too great the cable may be cycled 20 to 30 times to reduce friction.

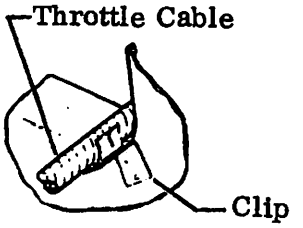
(16) Repeat steps 1 thru 15 to install opposite forward cable.

D. Install Aft Throttle Cables (See figure 202)

NOTE: The right and left aft throttle cables are of different lengths. The left aft cable is longer and is routed in a loop underneath the aft portion of the engine.

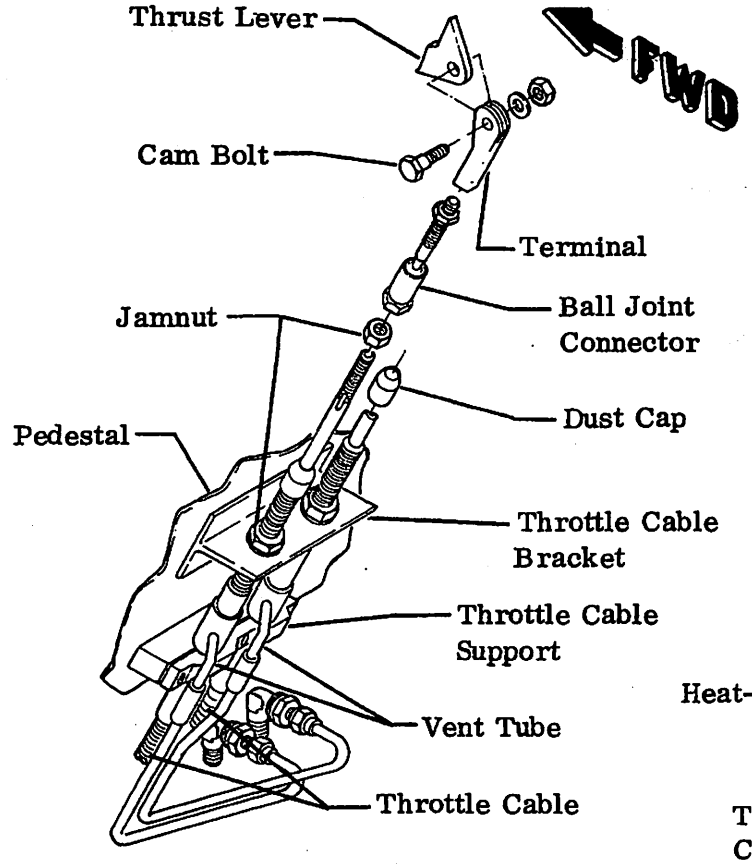
(1) Prepare the cable for installation as shown in details "M" and "N".
(2) Route cable (end opposite to coupling nut) through pylon and pylon firewall, assuring that cable does not rotate (refer to detail "P"). As cable is fed through firewall, place cable guide (detail "F") over cable. Continue to feed the cable through the firewall until approximately 44 inches of cable extends from firewall.
(3) Connect the forward and aft cables at the coupling.
(4) Check to assure that the cable is properly installed by stroking several times by hand. There shall be no appreciable increase in load.
(5) Repeat steps (2) through (4) of the above procedure to install the left aft throttle cable.
(6) Secure cable guides (detail "F") to pylon firewall. Connect cable to ball joint connectors at engine (detail "H") and center pedestal (detail "A").
(7) If applicable, slip firesleeve over cable.
(8) Clamp aft cables in same locations old cables were clamped using existing hardware. Assure that a minimum of 1.00 inch clearance exists between cables and hot section.
(9) Clamp forward cables in same locations old cables were clamped using existing hardware.
(10) Apply faying surface sealant to frame 15 feedthroughs and install feedthroughs.
(11) Install support halves (refer to detail "G").
(12) Clean and apply sealant to firewall cable guides on both firewalls.
(13) Rig throttle cables.
(14) Install screws and quadrant cover on pedestal. Install pedestal extension covers to floor structure.
(15) Install center pedestal panels by connecting electrical plugs and securing with screws.
(16) Install floorboards and carpet.
(17) Install all center access panels beneath the aircraft.
(18) Install lower engine nacelle.
(19) Install aircraft batteries.
(20) Connect and safety wire battery quick-disconnects and install tailcone access door.





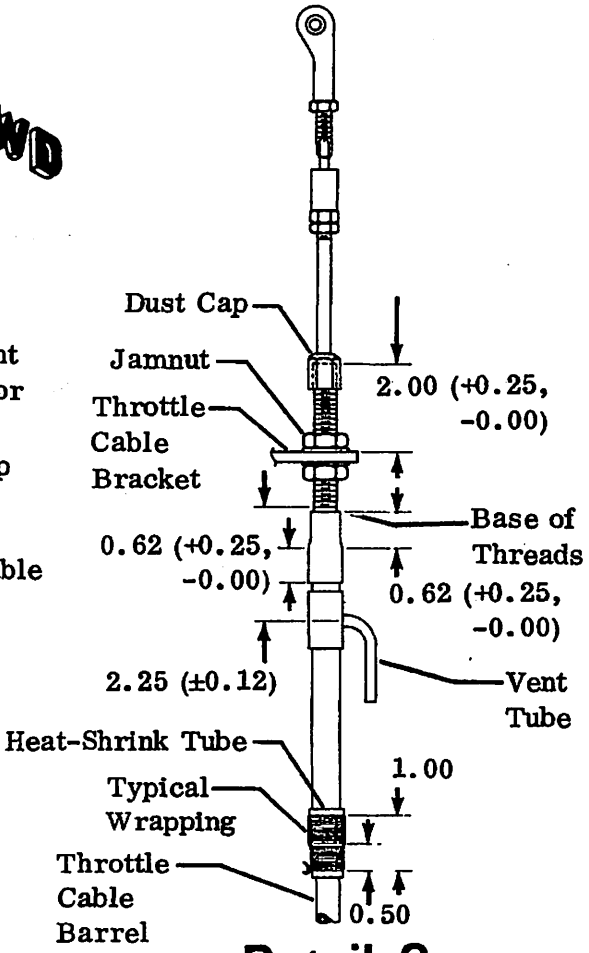
TYPICAL ALONG CABIN BULKHEADS

Detail B



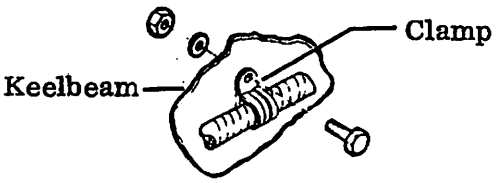
CONTROL PEDESTAL DETAIL

Detail A



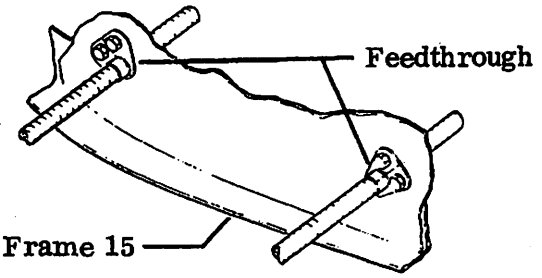
Detail Q

Throttle Cable Installation
Figure 202 (Sheet 1 of 5)



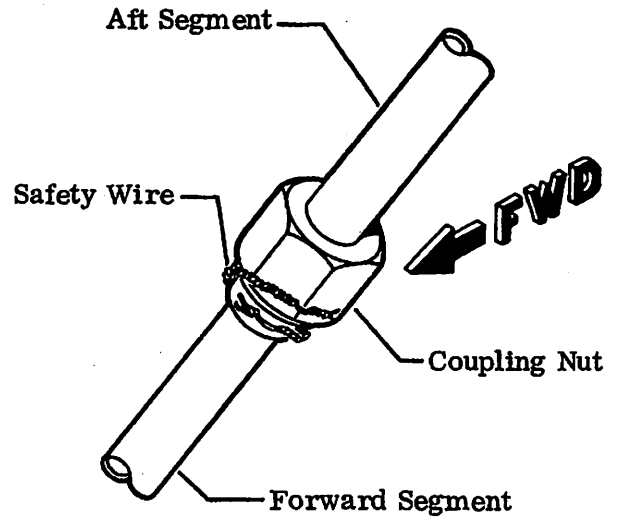
TYPICAL KEELBEAM CLAMP

Detail D



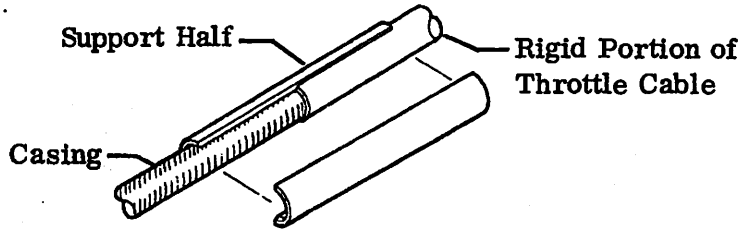
PRESSURIZED BULKHEAD FEEDTHROUGH

Detail C



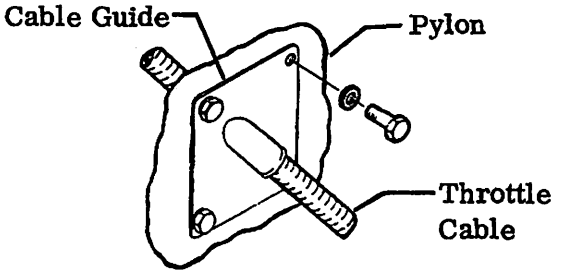
CABLE COUPLING INSTALLATION

Detail E



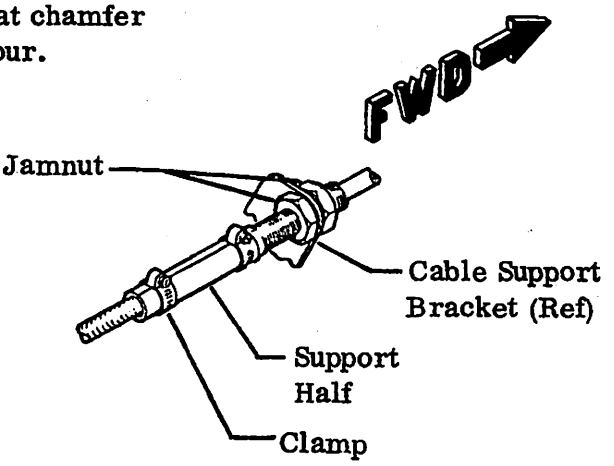
NOTE: Position support halves on cable so that chamfer mates with control cable surface contour.

TYPICAL SUPPORT HALF INSTALLATION



TYPICAL BOTH PYLONS

Detail F



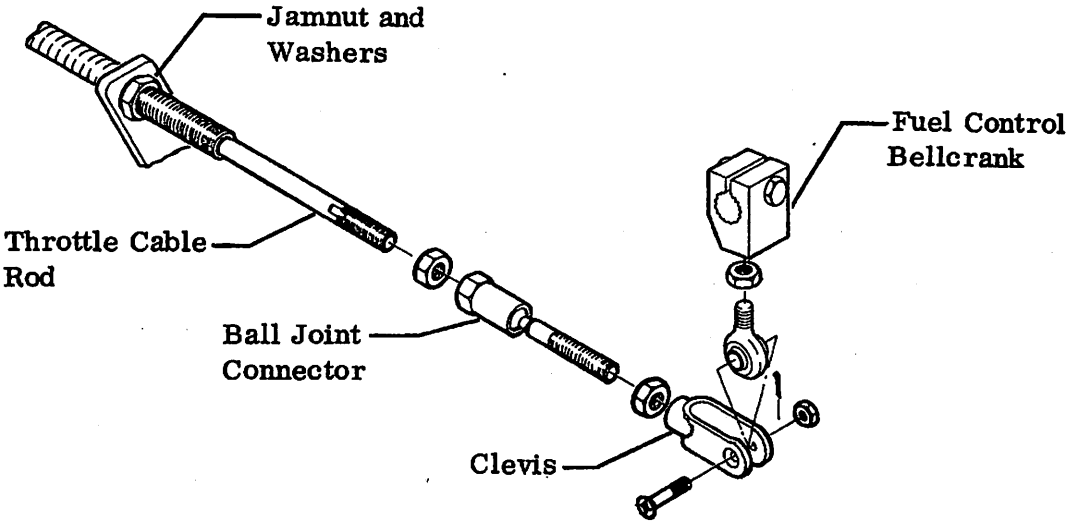
TYPICAL BOTH ENGINES

Detail G

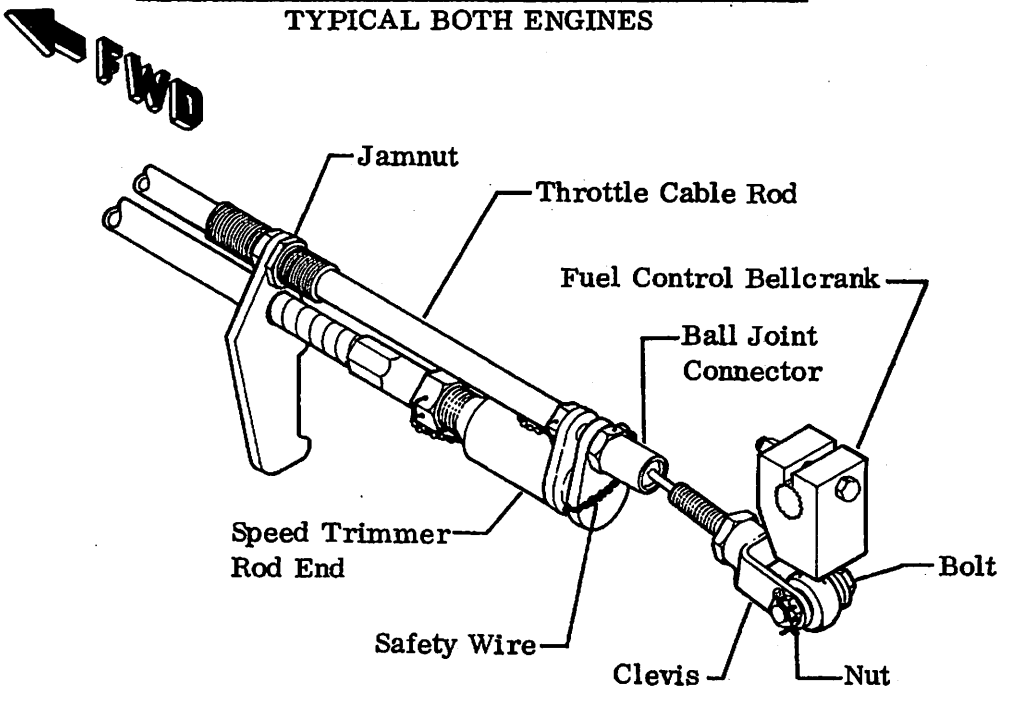
7-15A
H7-21A
D7-12B-2

Throttle Cable Installation
Figure 202 (Sheet 2 of 5)

EFFECTIVITY: ALL



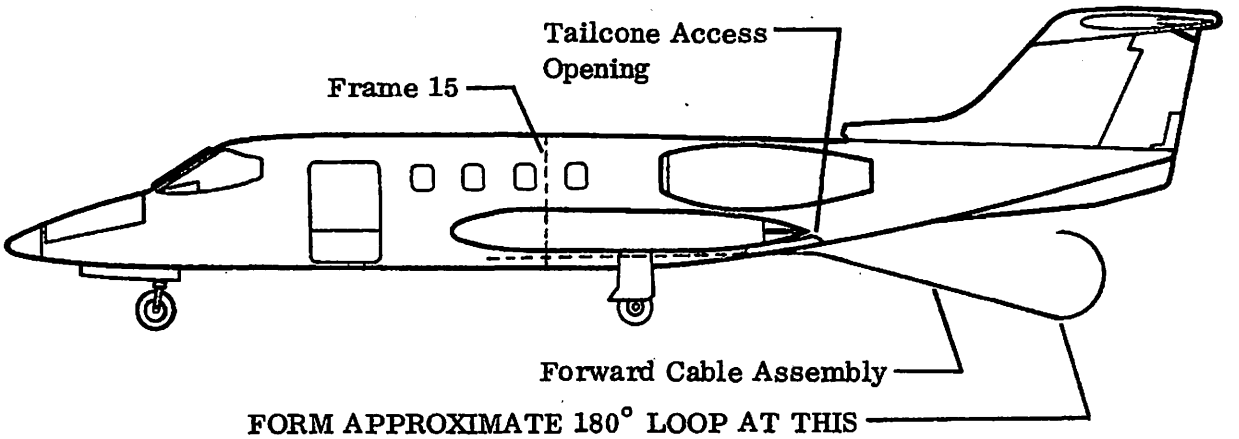
Aircraft Not Equipped with Engine Synchronizer
TYPICAL BOTH ENGINES



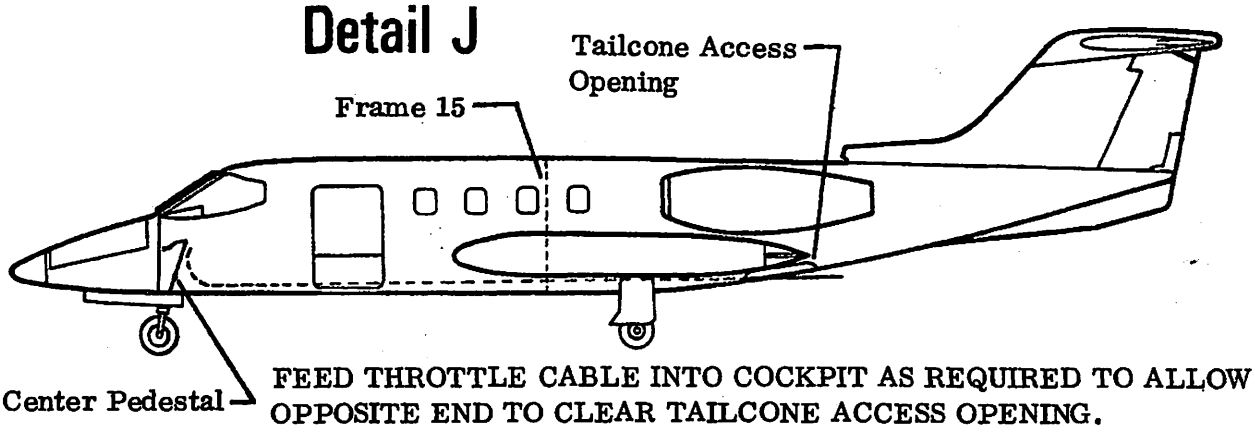
Aircraft Equipped with Engine Synchronizer
RH ENGINE ONLY

Detail H

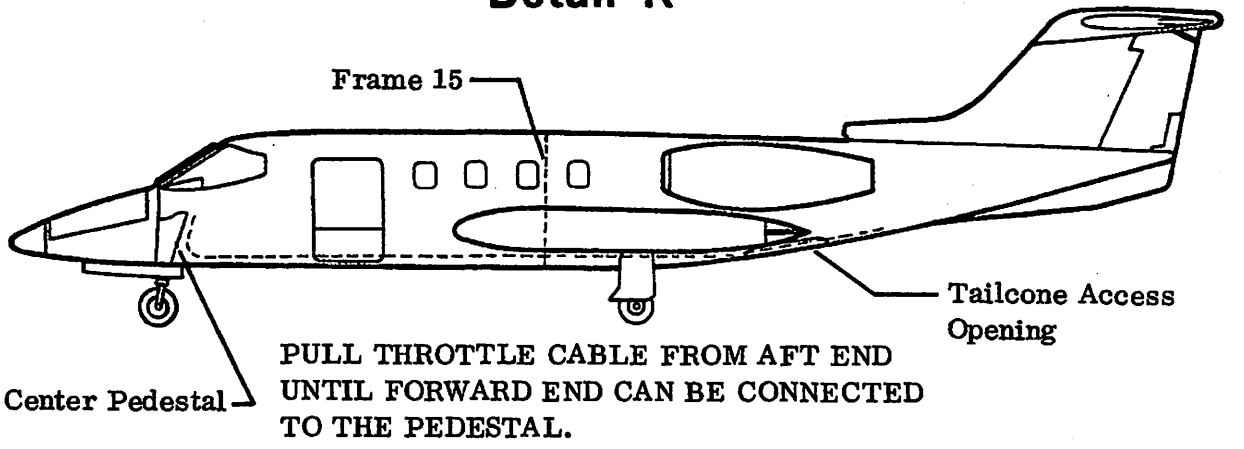
Throttle Cable Installation
Figure 202 (Sheet 3 of 5)



Detail J

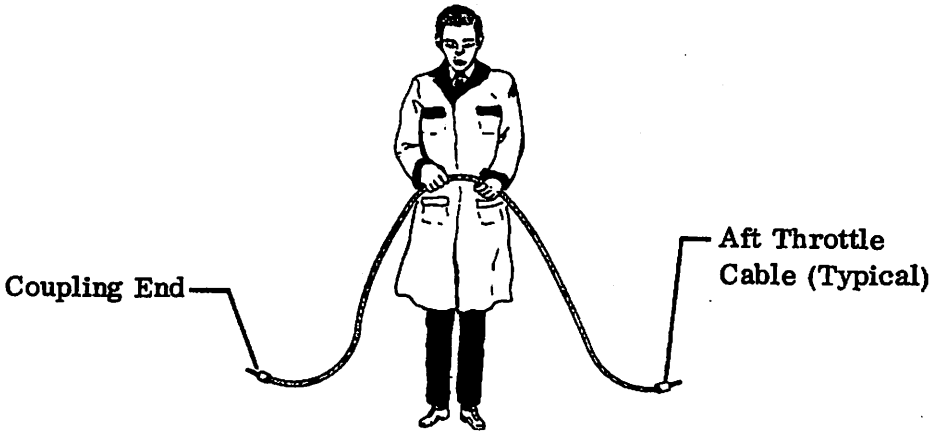


Detail K



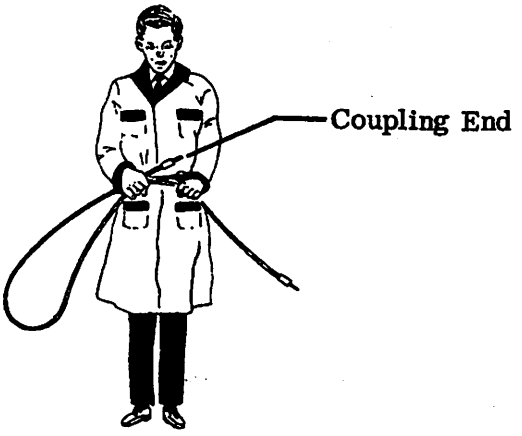
Detail L

Throttle Cable Installation
Figure 202 (Sheet 4 of 5)



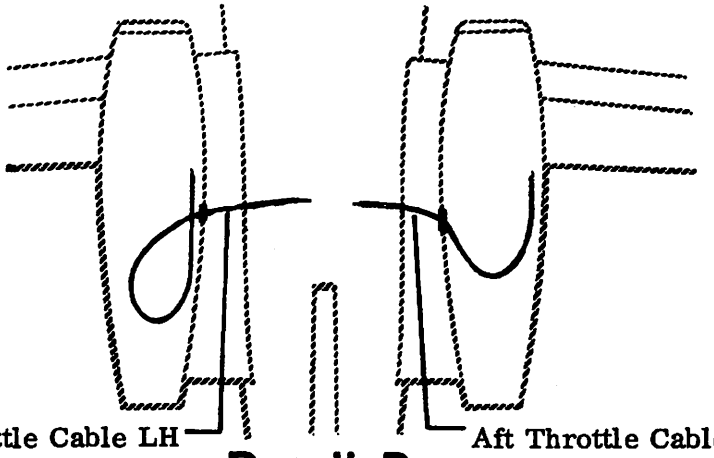
Hold cable up and rotate so that both ends curl up as shown.

Detail M



Bring coupling end up until it is tangent to center bend and can be held with one hand. Do not allow cable to rotate. This will properly align the cable for routing purposes.

Detail N



Detail P

Throttle Cable Installation
Figure 202 (Sheet 5 of 5)

4. Adjustment/Test

A. Throttle Cable Rigging (See figure 203.)

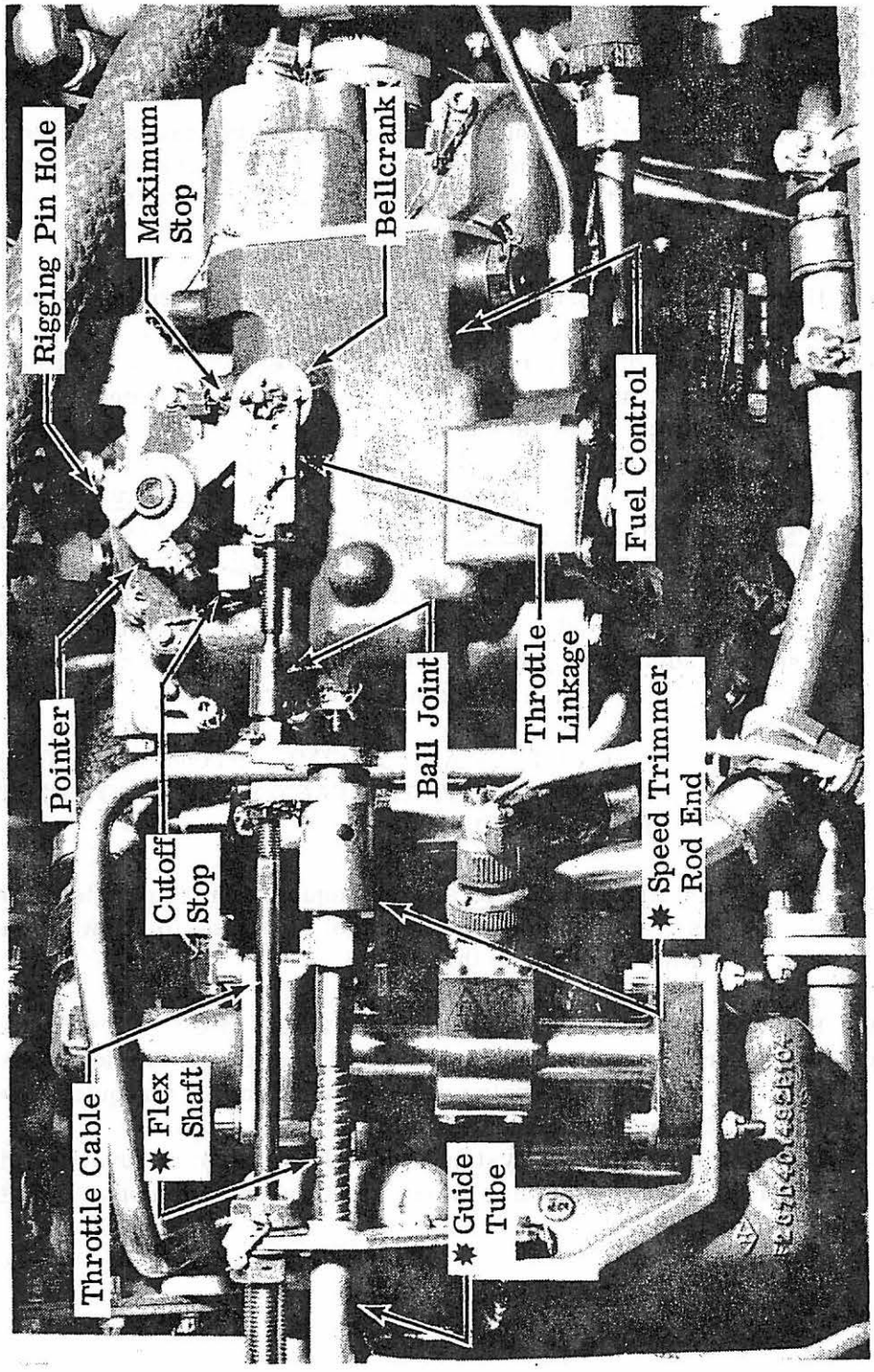
NOTE: Prior to rigging, assure that fuel control bellcrank rod end is indexed 180° from fuel control pointer. If engine synchronizer system is installed, assure that Synchronizer Switch is set to OFF and that trimmer has centered.

(1) Using a ruler and string, mark a line on quadrant cover at midpoint (45°) between throttle cutoff and maximum positions.
(2) Center travel of cable rod by adjusting to expose 2.25 inches of rod.
(3) Maintain 2.25 inch dimension and adjust balljoint connector in pedestal to center thrust lever on 45° mark.
(4) With rod remaining centered, adjust ball joint connector on engine end of cable to align fuel control pointer at 45°. On Aircraft equipped with engine synchronizer system, center speed trimmer so that lengthening it by 2.5 turns will allow 100% throttle setting. Shortening trimmer by 5 turns from 100% setting shall allow throttle to reach cutoff position.
(5) Set thrust lever to idle and insert rigging pin. If rigging pin cannot be inserted, adjust ball joint connector until rigging pin can be inserted. Tighten and safety wire ball joint connector.

CAUTION: THE CUTOFF AND MAXIMUM STOPS ARE SAFETIED AND SEALED AT THE FACTORY AND NO ADJUSTMENT IS REQUIRED.

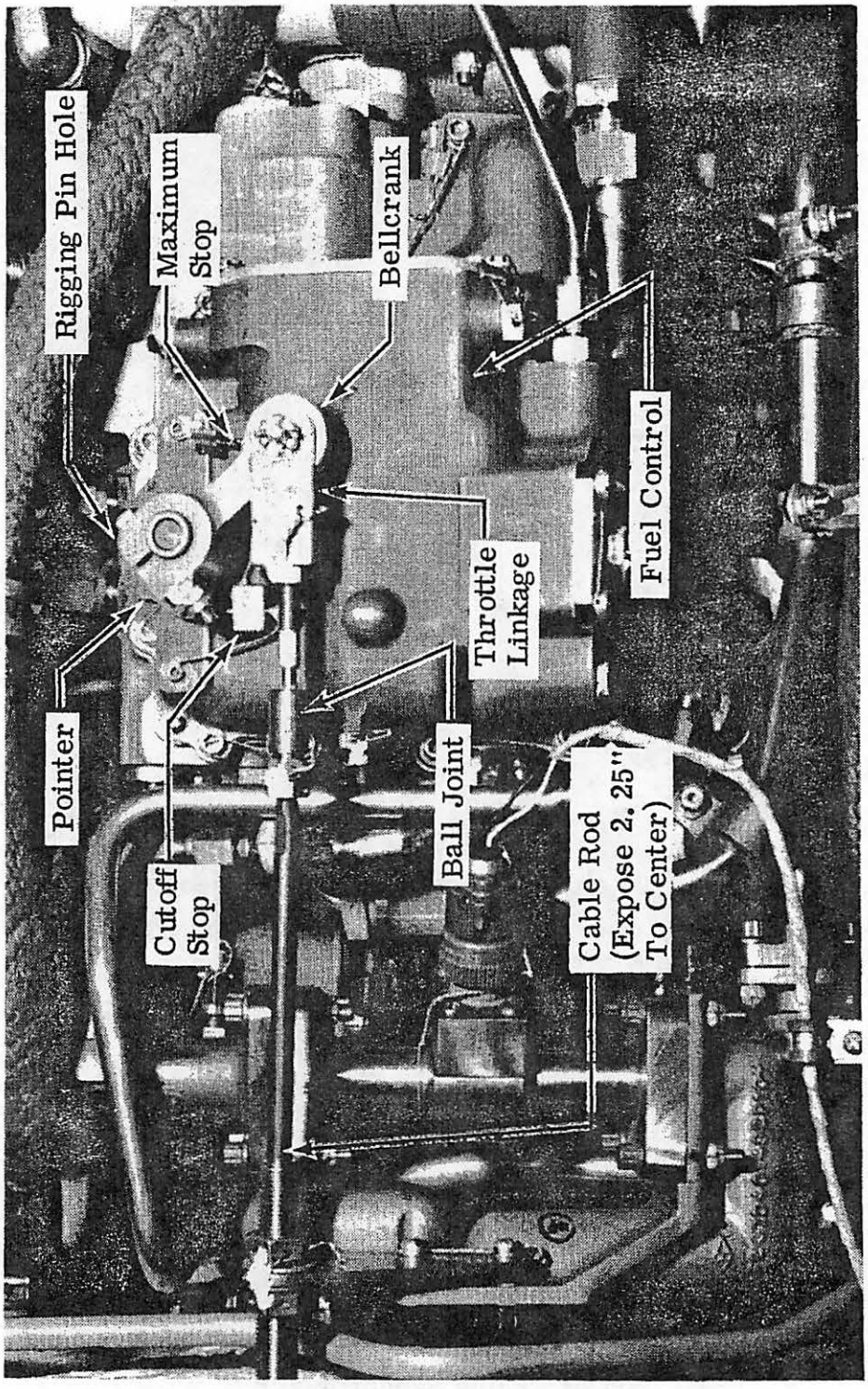
NOTE: On Aircraft 25-165 and Subsequent, an adjustable rod end is installed on the fuel control bellcrank to allow further adjustment of the throttle.

(6) Remove rigging pin and check for full travel of thrust levers.
(7) Run up engine and perform operational check. Engine idle speed shall be 49.5% (±0.5%). If engine speed adjustments are required, refer to Engine Maintenance Manual SEI-186.
(8) If engine synchronizer system is installed, perform functional test in accordance with applicable Woodward Governor Company Bulletin. Refer to 76-11-00.



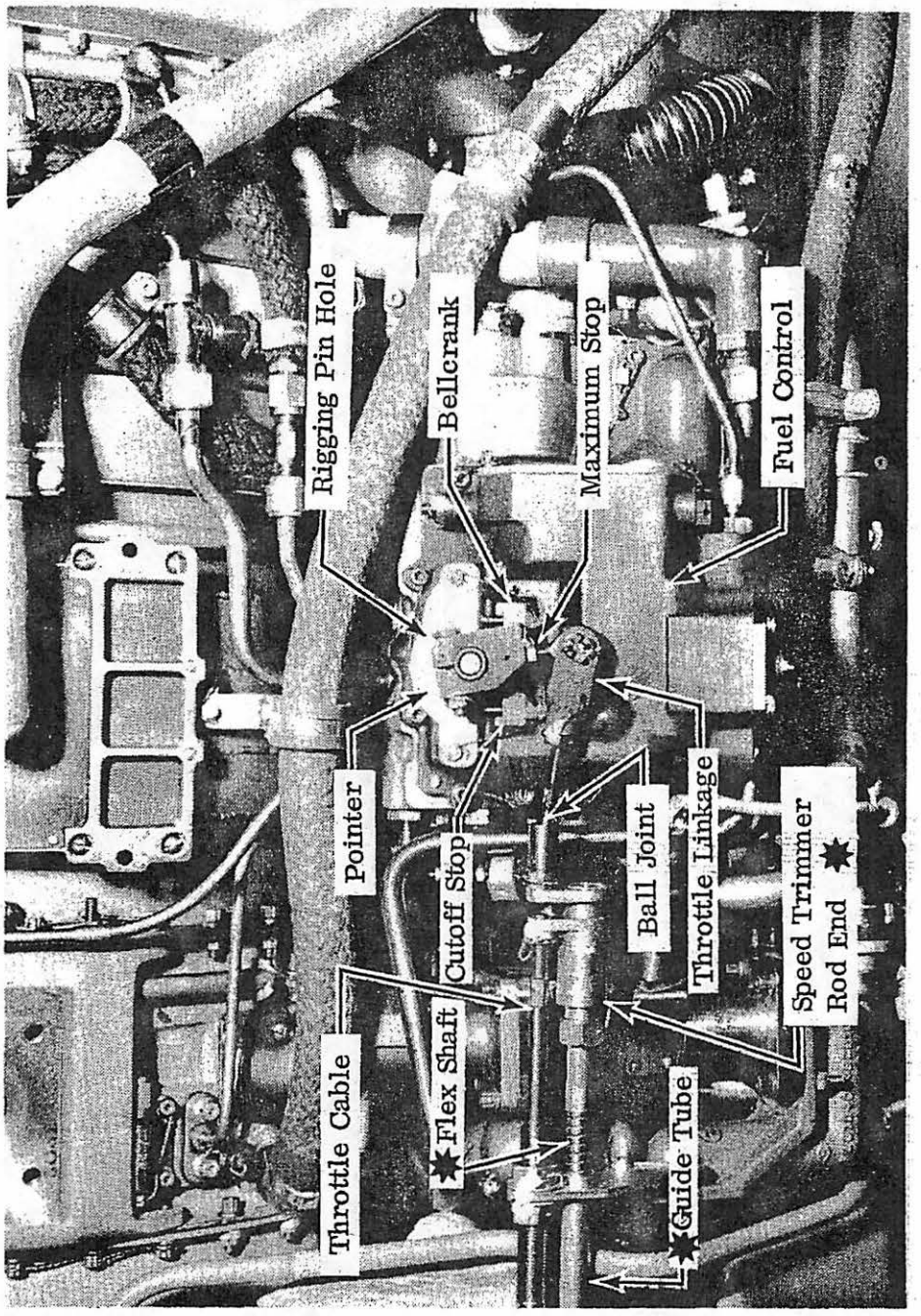
✸ Part of Engine Synchronizer

Throttle Cable Rigging
Figure 203 (Sheet 1 of 4)



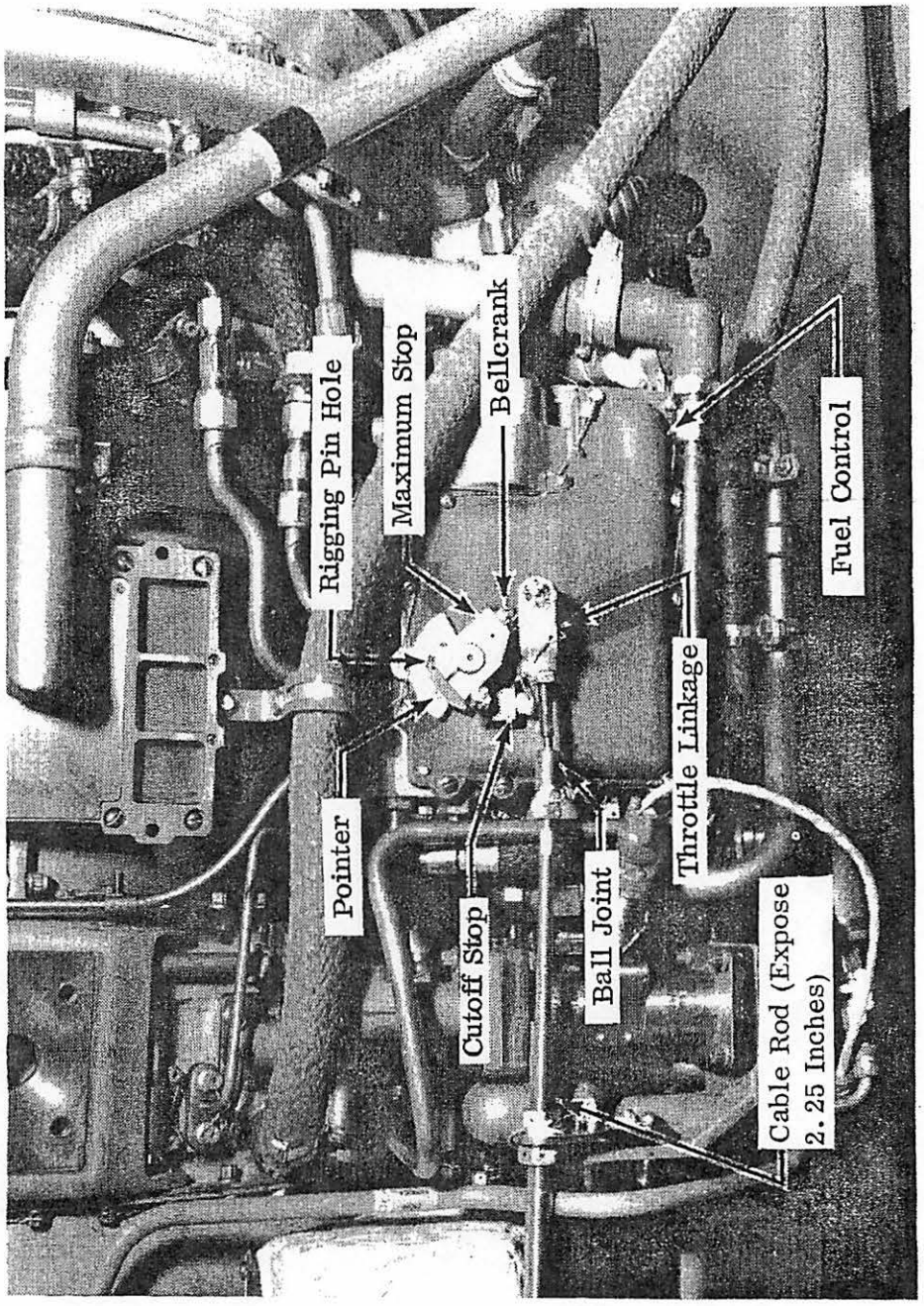
Throttle Cable Rigging
Figure 203 (Sheet 2 of 4)

EFFECTIVITY: 25-061, 25-070 THRU 25-164 NOT EQUIPPED WITH ENGINE SYNCHRONIZER



✸ Part of Engine Synchronizer

Throttle Cable Rigging
Figure 203 (Sheet 3 of 4)

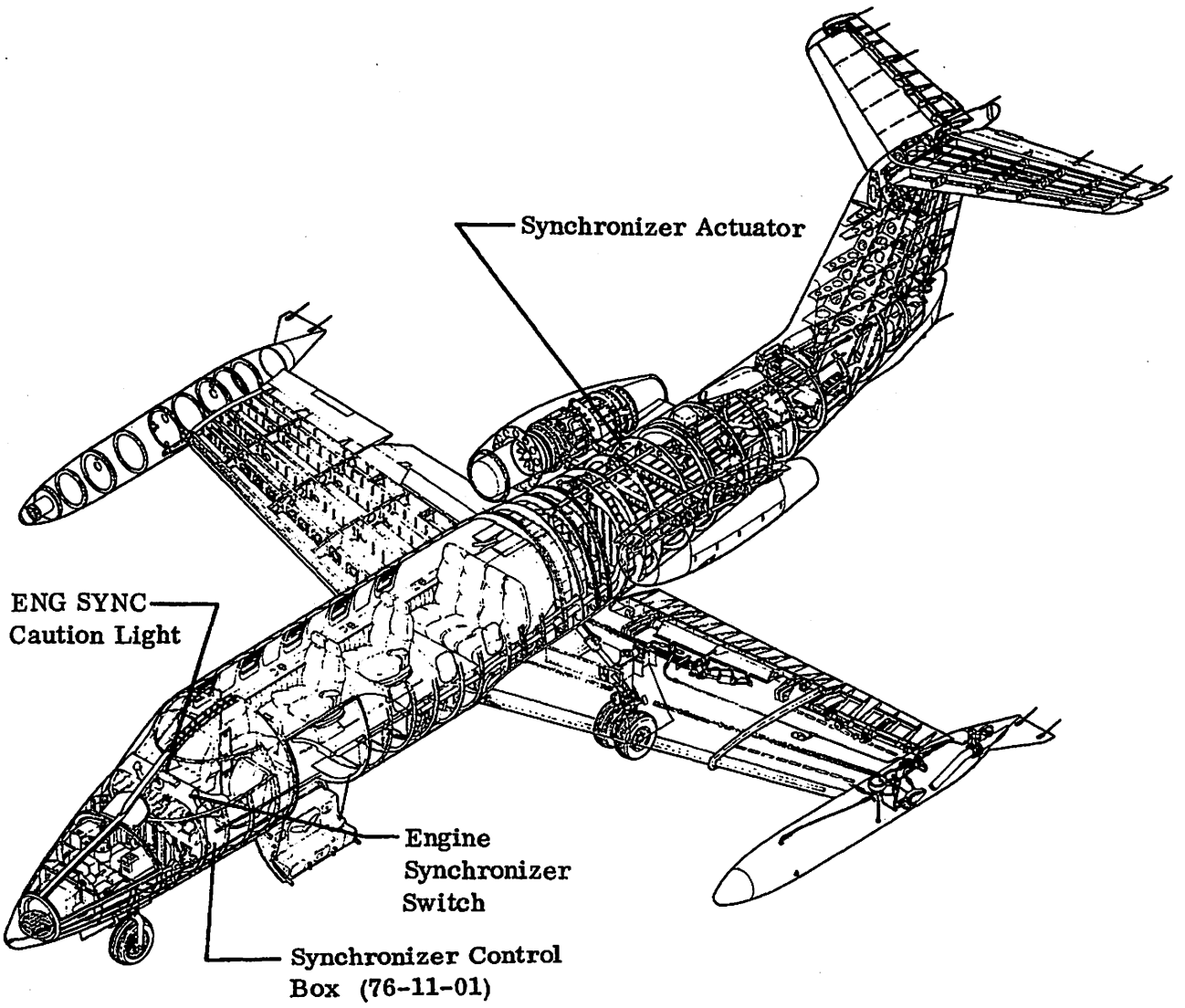


Throttle Cable Rigging
Figure 203 (Sheet 4 of 4)

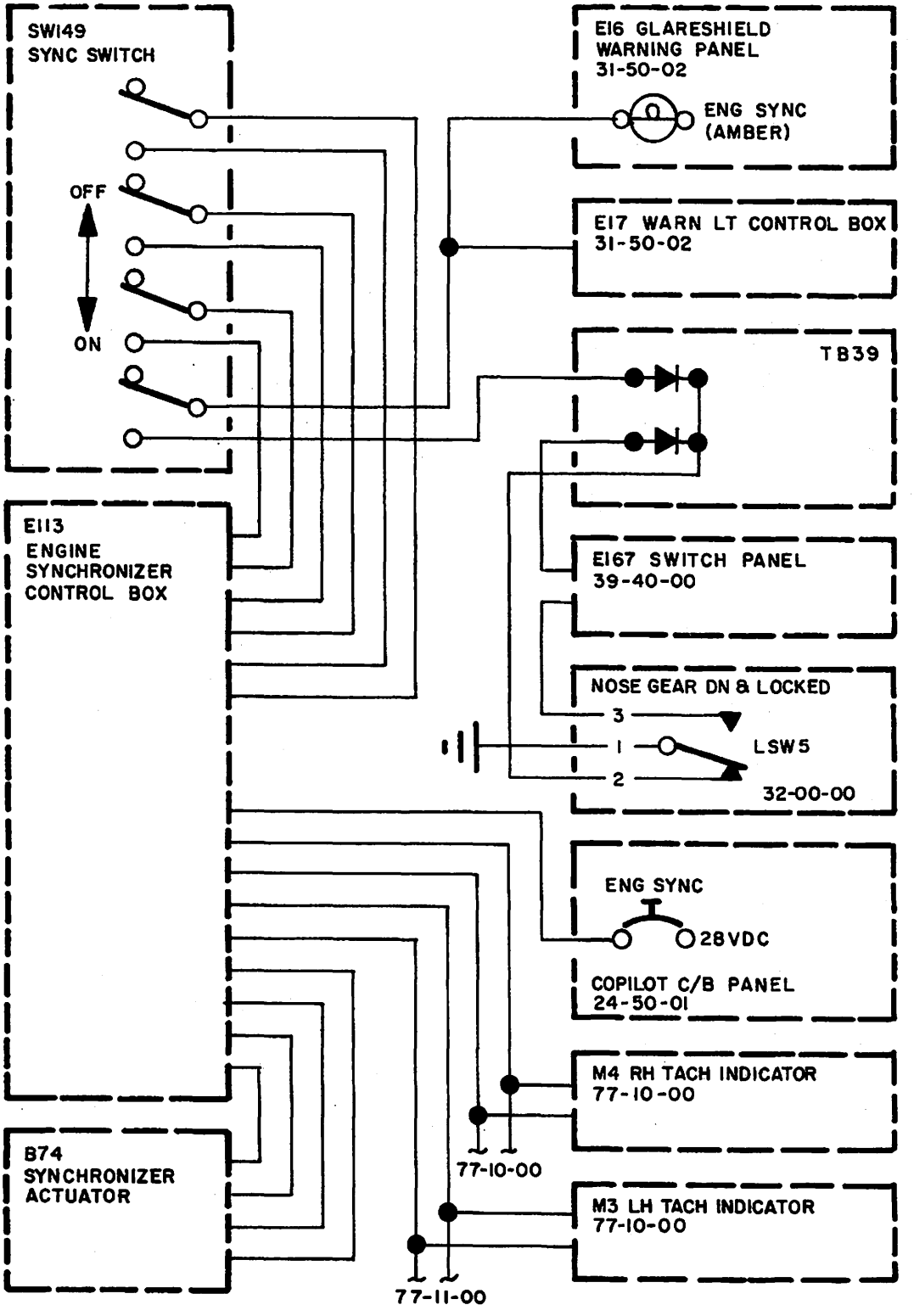
ENGINE SYNCHRONIZER SYSTEM - DESCRIPTION AND OPERATION

1. Description (See figure 1.)
 A. The engine synchronizer system consists of an actuator connected to the throttle linkage, a synchronizer control box, an ENG SYNC caution light (amber), a terminal board, a circuit breaker, and a system switch.
 B. Component Description
 (1) The synchronizer actuator is located aft of the RH side of the aft engine beam and is connected to the throttle linkage on the RH (slave) engine.
 (2) The synchronizer control box is located between frames 6 and 7 and between stringers 12L and 13L.
 (3) The ENG SYNC caution light (amber) is located on the glareshield warning light panel.
 (4) The terminal board (TB 39) is located aft of frame 5 at RBL 7.
 (5) The circuit breaker is located on the copilot's circuit breaker panel.
 (6) The ON-OFF system switch is located on the quadrant cover.

2. Operation (See figure 2.)
 A. The engine synchronizer control box receives electric pulses from each tachometer generator. A difference in the pulse rates causes the control box to run the actuator. The actuator, through the throttle linkage, trims the slave engine to correspond to the master engine rpm. For further information on the engine synchronizer system, refer to the applicable Woodward Bulletin. On Aircraft 25-061 and 25-070 thru 25-133, refer to Bulletin No. 33071 (approved by STC SA412CE). On Aircraft 25-134 thru 25-223, refer to Bulletin No. 33104 (approved by STC SA30GL). On Aircraft 25-224 and Subsequent, refer to Bulletin No. 33144 (approved by STC SA30GL). These Bulletins are published by Woodward Governor Company, Rockford, Illinois.



Engine Synchronizer System Component Locator
Figure 1



Engine Synchronizer System Electrical Control Schematic
Figure 2

ENGINE SYNCHRONIZER CONTROL BOX - MAINTENANCE PRACTICES

1. Removal/Installation

A. Remove Synchronizer Control Box (See figure 201.)

(1) Remove electrical power from aircraft.

(2) Remove pilot's circuit breaker panel to gain access to synchronizer control box. (Refer to Chapter 24.)

(3) Disconnect electrical connectors from synchronizer control box wiring.

(4) Remove attaching parts and synchronizer control box from aircraft.

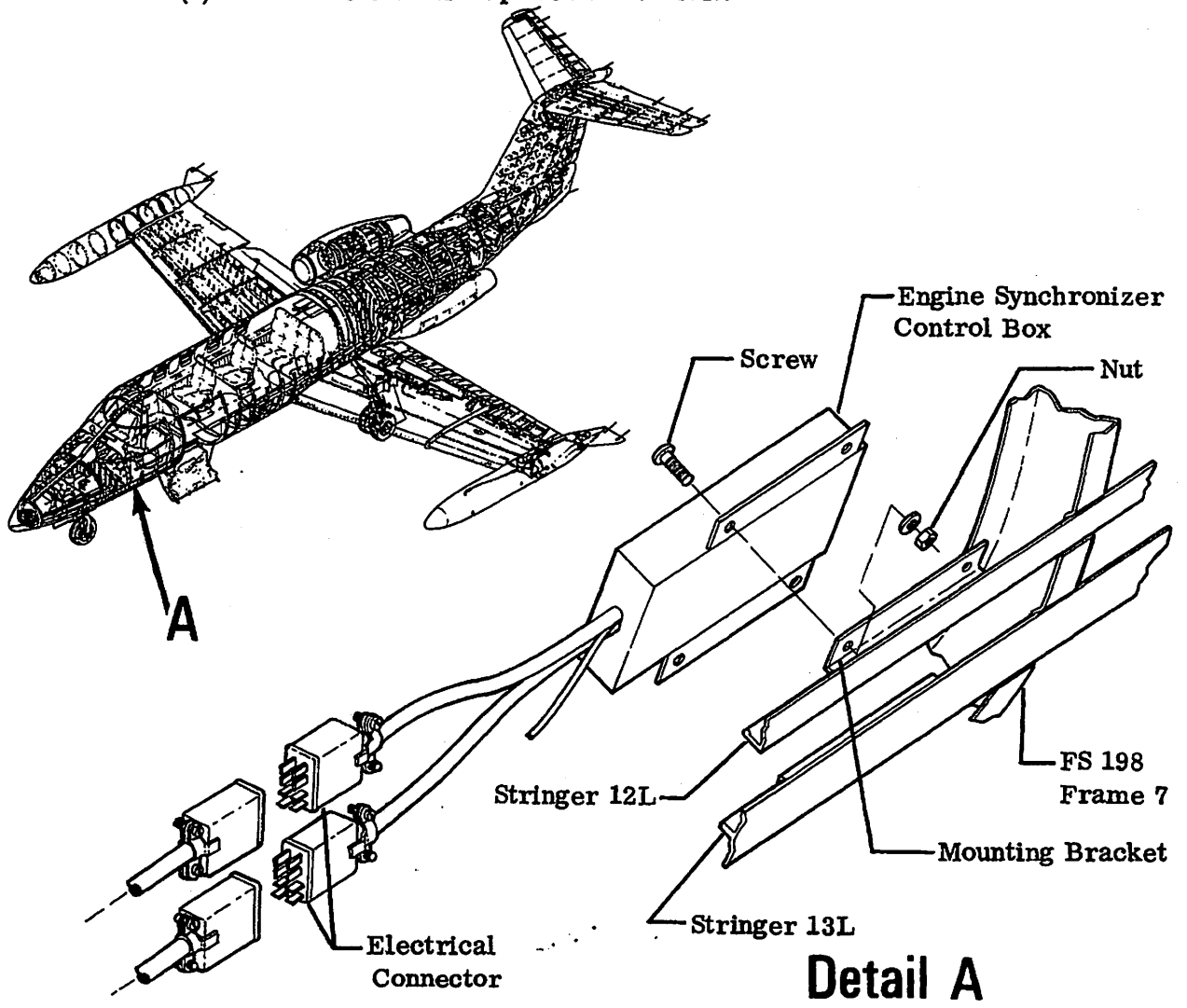
B. Install Synchronizer Control Box (See figure 201.)

(1) Install synchronizer control box and secure with attaching parts.

(2) Connect electrical connectors to synchronizer control box wiring.

(3) Install pilot's circuit breaker panel. (Refer to Chapter 24.)

(4) Restore electrical power to aircraft.



Engine Synchronizer Control Box Installation
Figure 201

9-325B

EFFECTIVITY: OPTIONAL